# Recent Tevatron Operations + Last Week's Failure in D3

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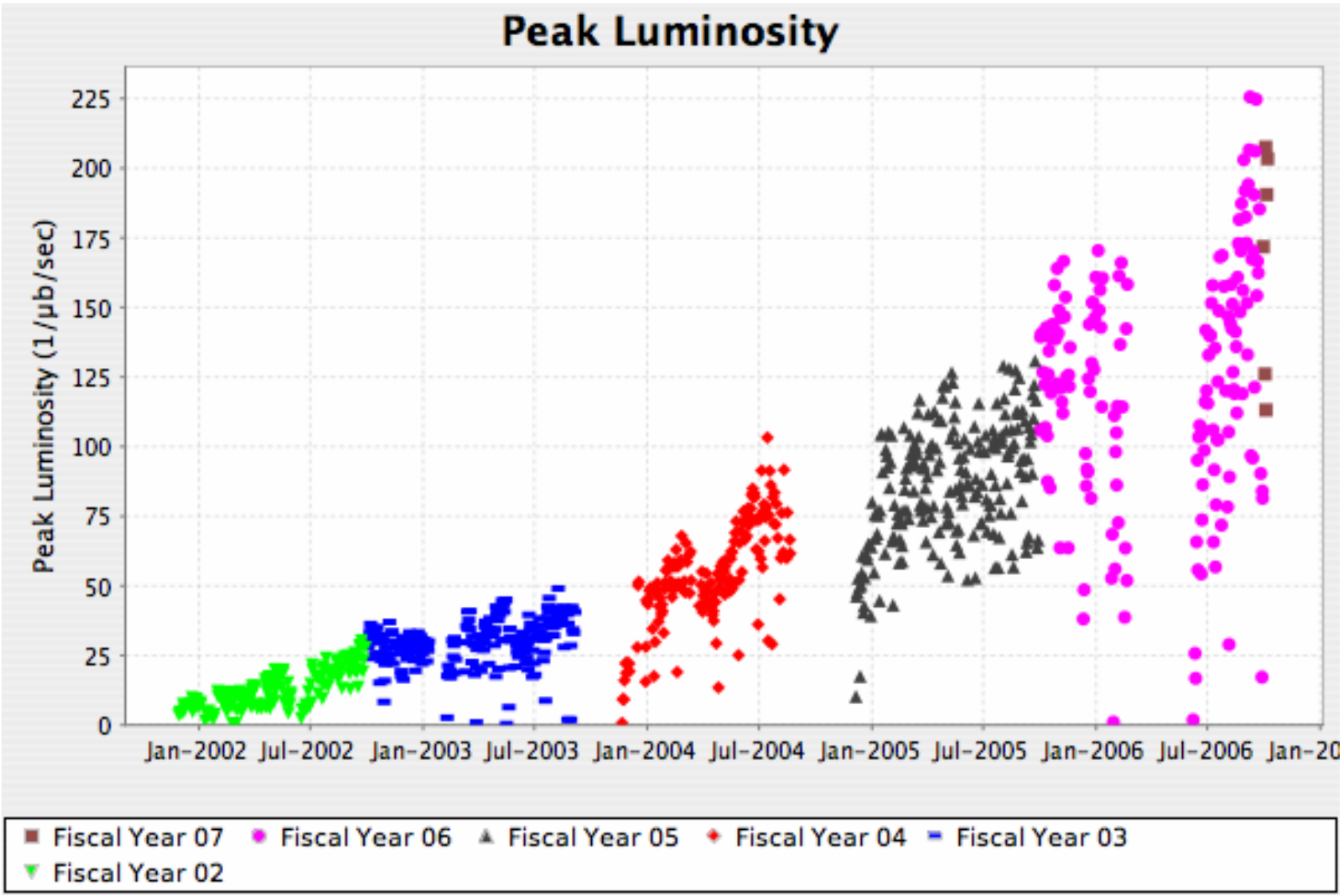
# Tevatron-centric View of Post-Shutdown Operation

- Notable achievements since the long shutdown ended
  - Delivered lumi / week = 33.3 $pb^{-1}$
  - Delivered lumi from Aug 28-Sep 3 ≈ 119 $pb^{-1}$
  - Peak luminosity = 238 $10^{30}$ $cm^{-2}$ $s^{-1}$
  - Record # pbars at start HEP ≈ 2870 $10^{9}$

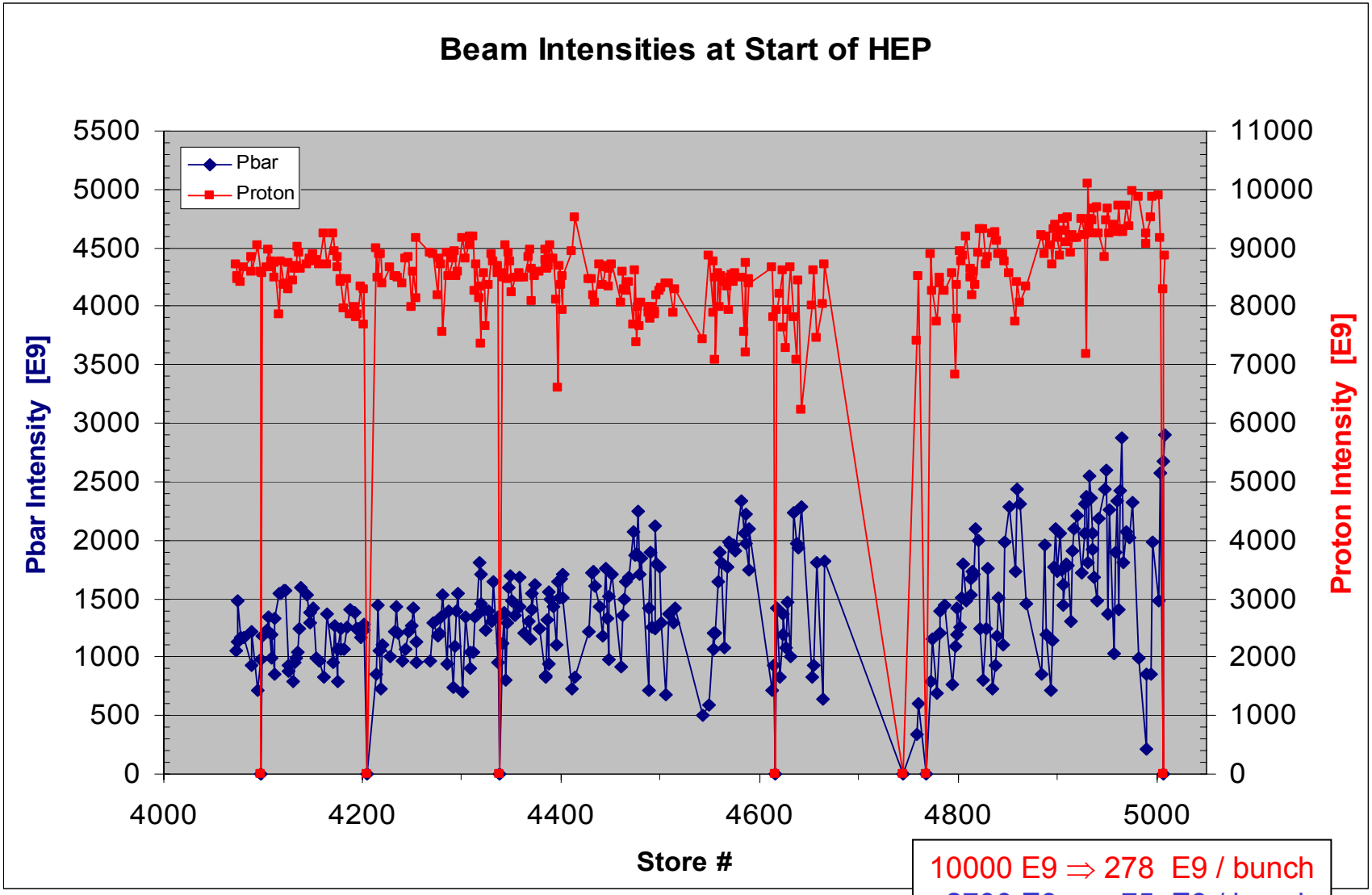
| Comparison between pre- and post-shutdown record stores | | | |
|---|---|---|---|
| Store | Initial Lumi* [$10^{30}$ $cm^{-2}s^{-1}$] | # protons [$10^{9}$] | # pbars [$10^{9}$] |
| 4581 | 180 | 8480 | 2340 |
| 4964 | 238 | 9300 | 2870 |
| Δ(4581→4964) | +32% | +9.5% | +22.5% |

** Includes +6% increase for D0 lumi scale correction*

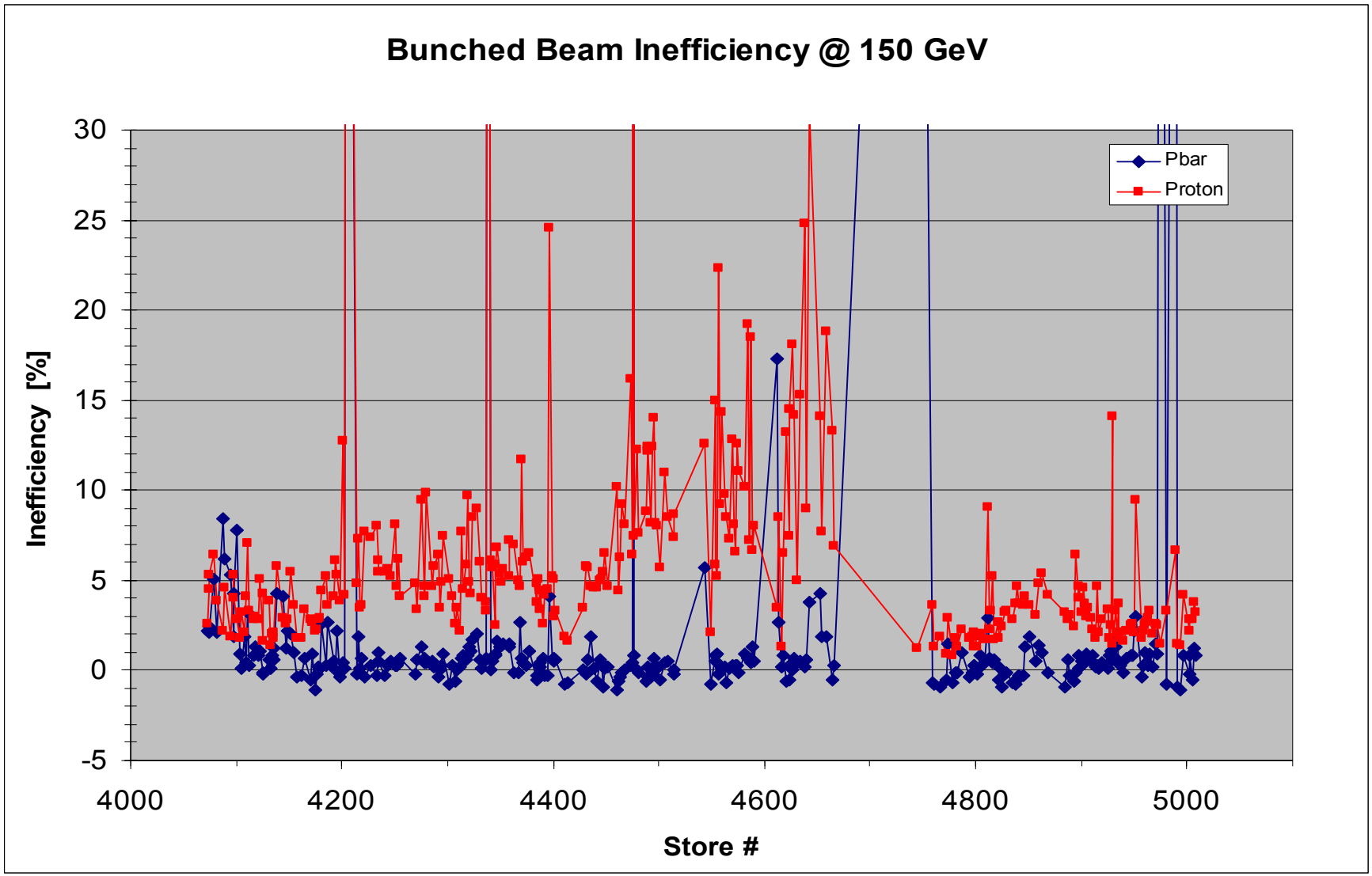
# Run II Peak Luminosities



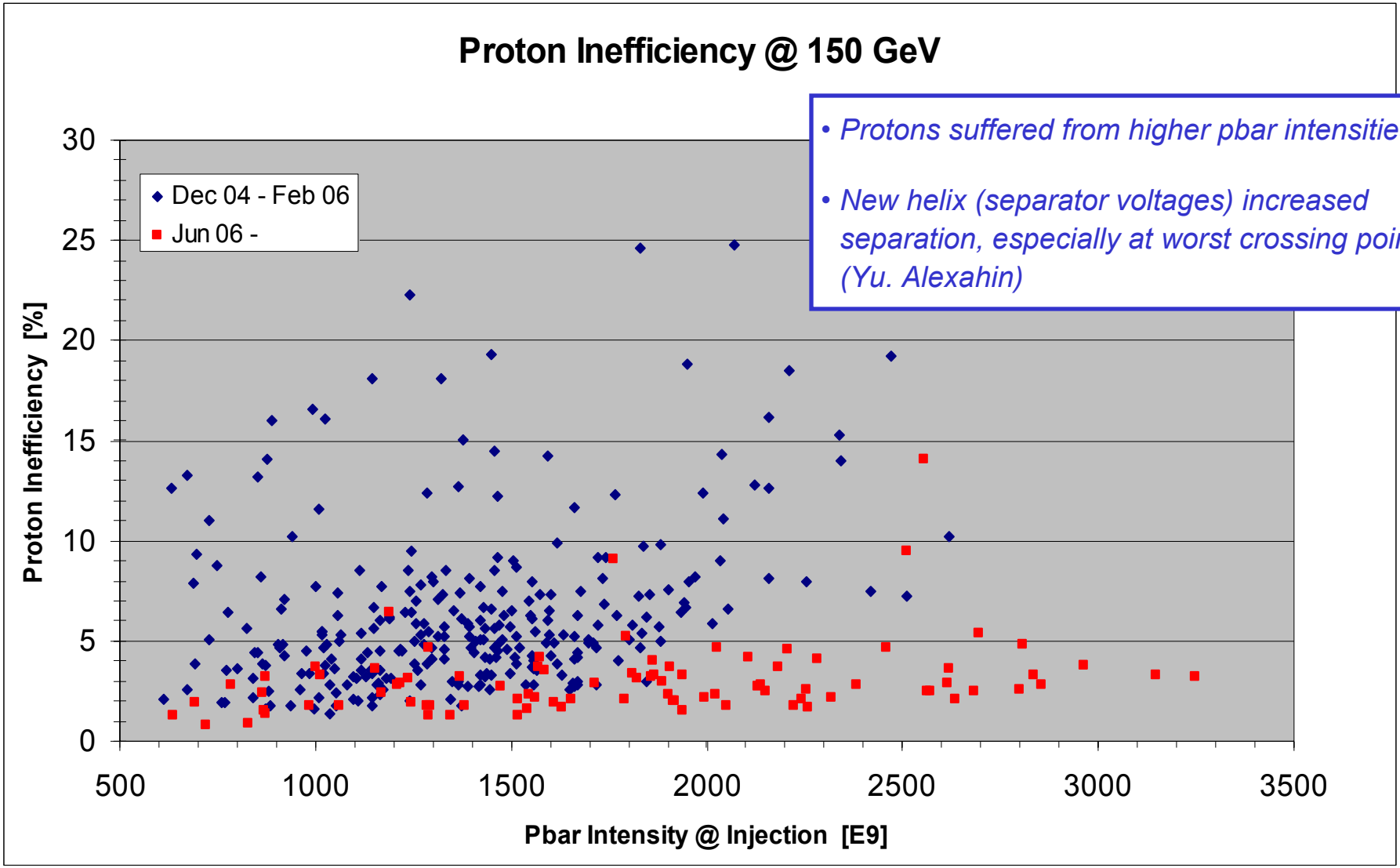
# Increasing Beam Intensities



# Reduced Tevatron Beam Loss @ 150 GeV



# Reduced Beam-Beam Effects @ 150 GeV




- *Protons suffered from higher pbar intensities*
- *New helix (separator voltages) increased separation, especially at worst crossing point (Yu. Alexahin)*

# Tevatron Luminosity Lifetimes

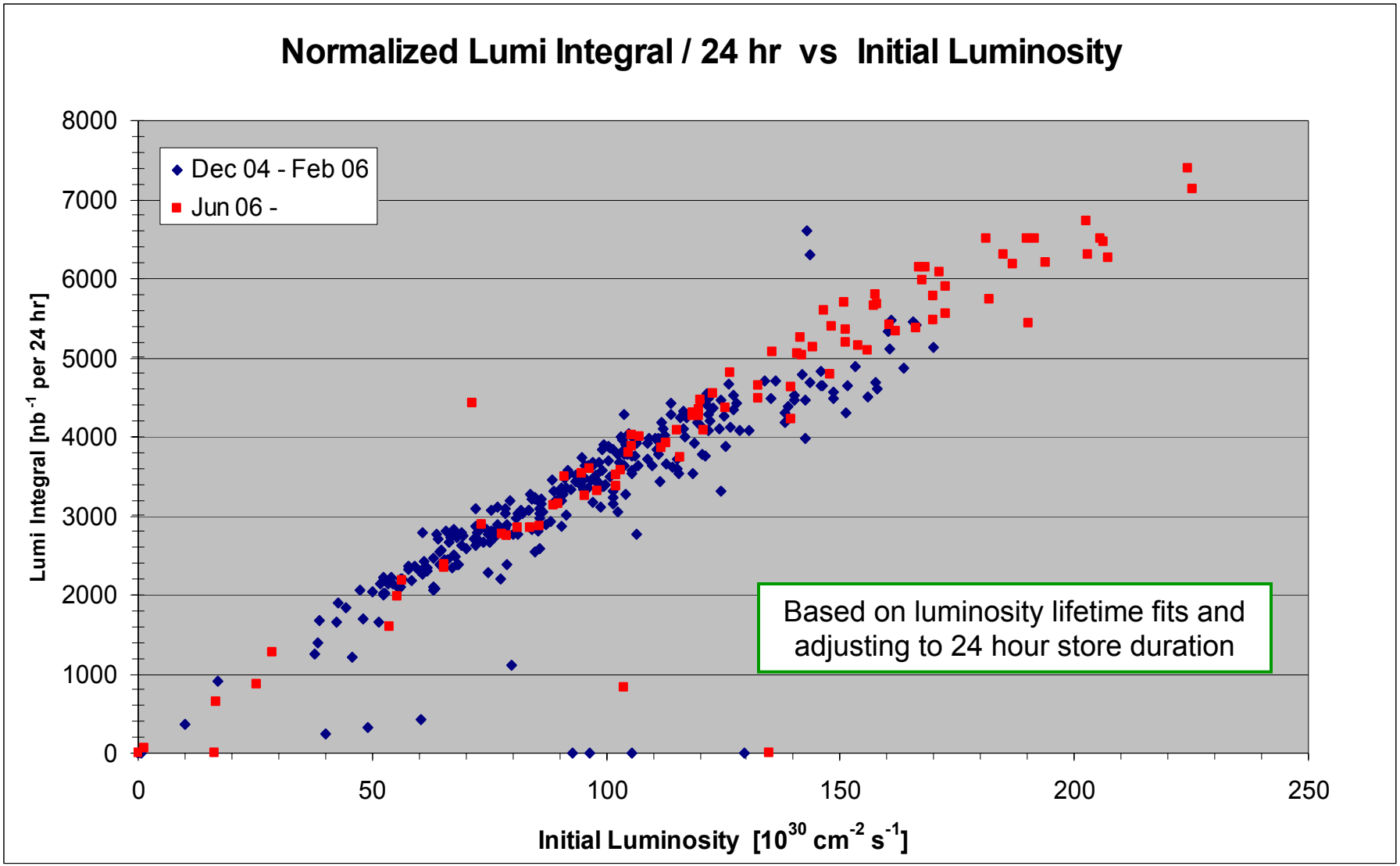
- Long-range beam-beam effects degrade luminosity lifetime + integral
  - Nearest parasitic crossings (≈59 m from IPs) especially bad
- During shutdown, additional separators installed to increase separation
  - More separation ⇒ reduced beam-beam effects
  - ~20% increase @ upstream IP
  - Not as much @ downstream IP

Beam separation near IPs (in σ's)

| | B0 US | B0 DS | D0 US | D0 DS |
|---|---|---|---|---|
| Before | 5.4 | 5.6 | 5.0 | 5.2 |
| After | 6.4 | 5.8 | 6.2 | 5.6 |

  - *Thanks to TD for helping us with the separators*
- Luminosity lifetime improved ~20% compared to pre-shutdown running
  - Increased integrated luminosity per store (for given store length)

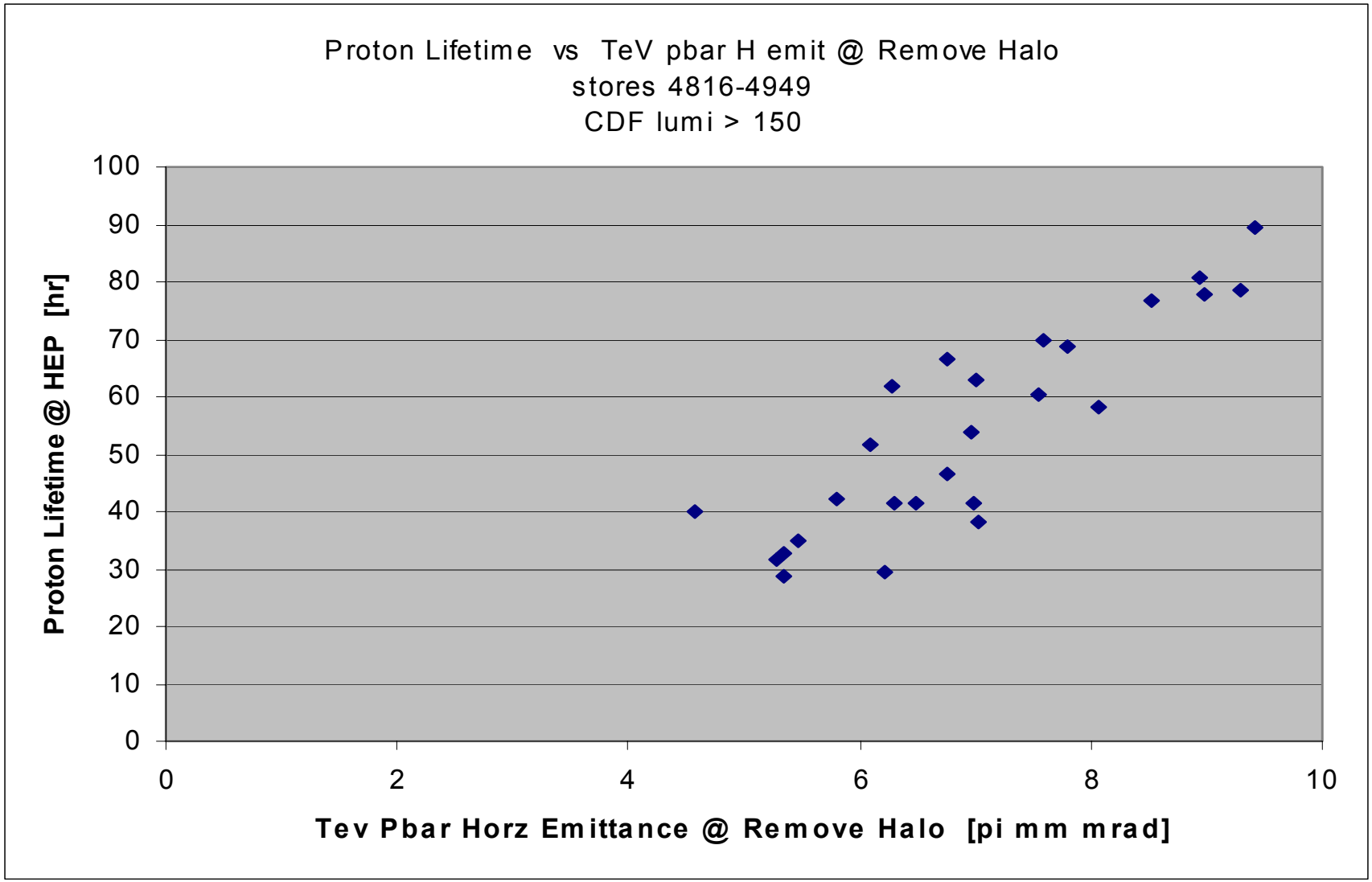
# Better Lifetime ⇒ More Delivered Luminosity



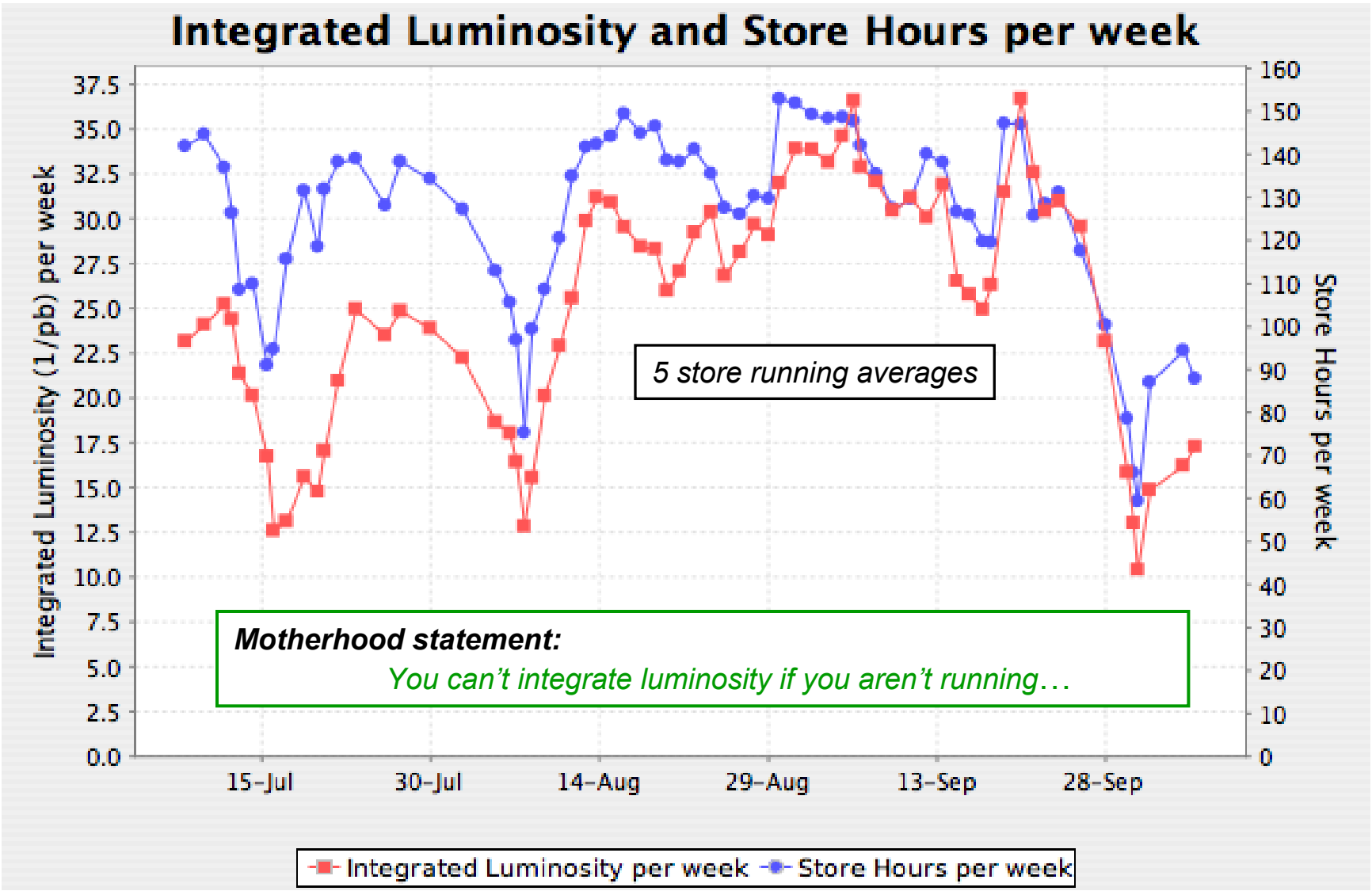
# Smaller Pbar Emittances from Recycler

- New Recycler tune reduced emittance growth rate *(mid-August)*
  - ⇒ Brighter (smaller emittance) pbars delivered to Tevatron
  - ⇒ **Higher instantaneous luminosity for same number of pbars…**
  - ⇒ **…consequently lower luminosity lifetime** (but still worth it for $\int L$)
  - ⇒ Smaller emittances also improves pbar and proton efficiencies in Tevatron
  - ⇒ Proton lifetime in collisions decreased as well

# Proton Lifetime @ HEP vs Pbar Horz Emittance



# Reliability



# Summary

- Record running in August/September thanks to performance and reliability of all machines
  - More beam to HEP and improved luminosity lifetime in Tevatron
  - More protons on pbar target (Linac / Booster / Main Injector)
  - Near record pbar stacking rates (Debuncher / Accumulator)
  - Smaller pbar emittances from Recycler
  - Good reliability and luck to avoid (most of) Mother Nature's wrath

# Component Failure in D3

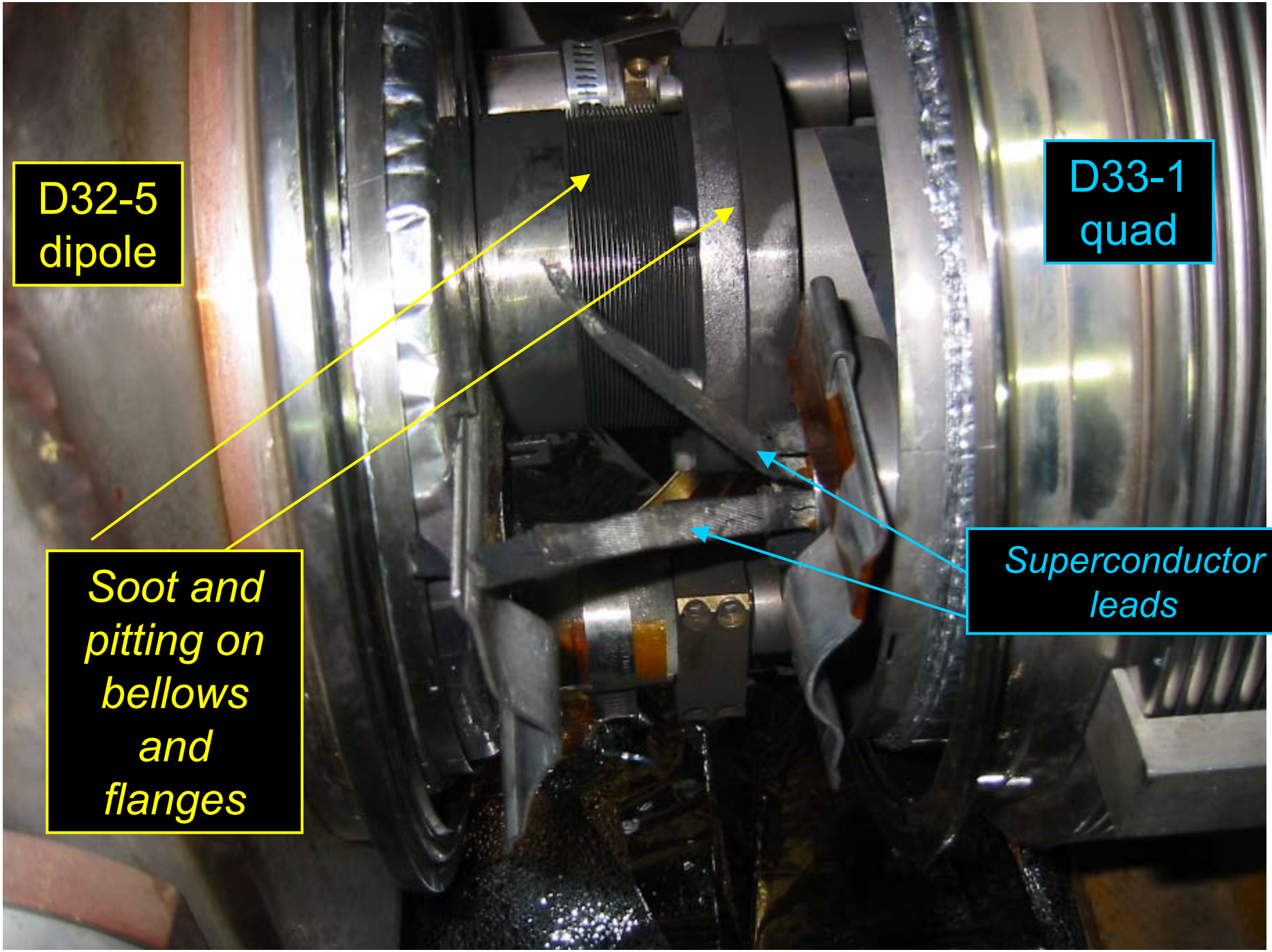
***(we need less expensive mouse traps)***

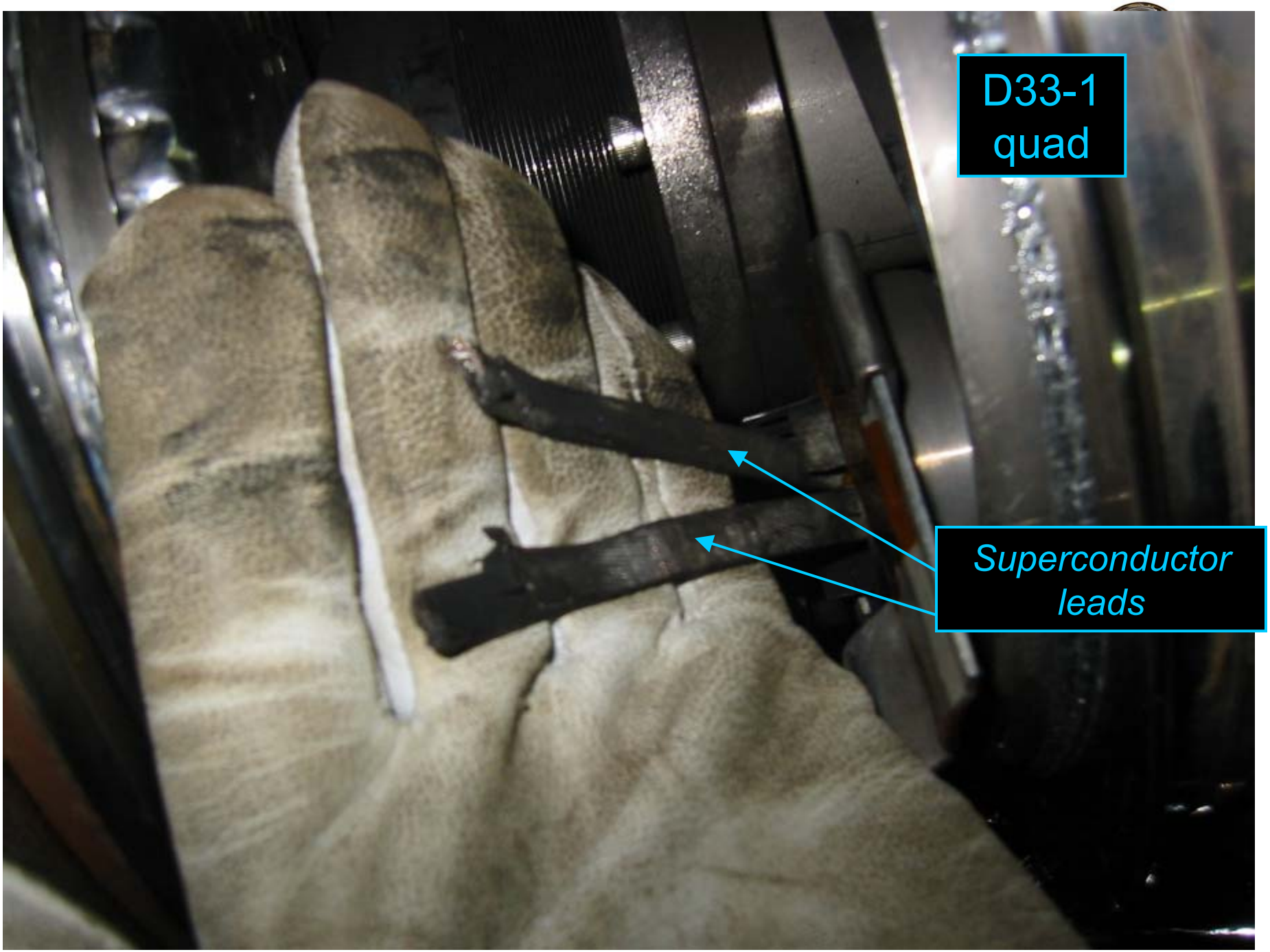
# The Chain of Events

- HEP store 5008 happily spinning
  - Record # pbars injected into Tev, record # pbars reach HEP start
- Mouse seeks Feeder 46B cubicle as possible new, cozy home
  - Flashover + resulting nasty power glitch affects many systems
  - Many UPS units switched over
- Tevatron ramp begins to dump on A2 power supply trip
  - Beams aborted cleanly
- 1.2 sec into ramp dump, D3 QPM reboots (**Q**uench **P**rotection **M**onitor)
  - Why? Glitch not filtered out by UPS? UPS tested fine later…
  - As designed, QPM fired heaters, generating whole-house quench
- ≈4 sec into ramp dump, ground fault developed in D3
  - D32-5 dipole failed

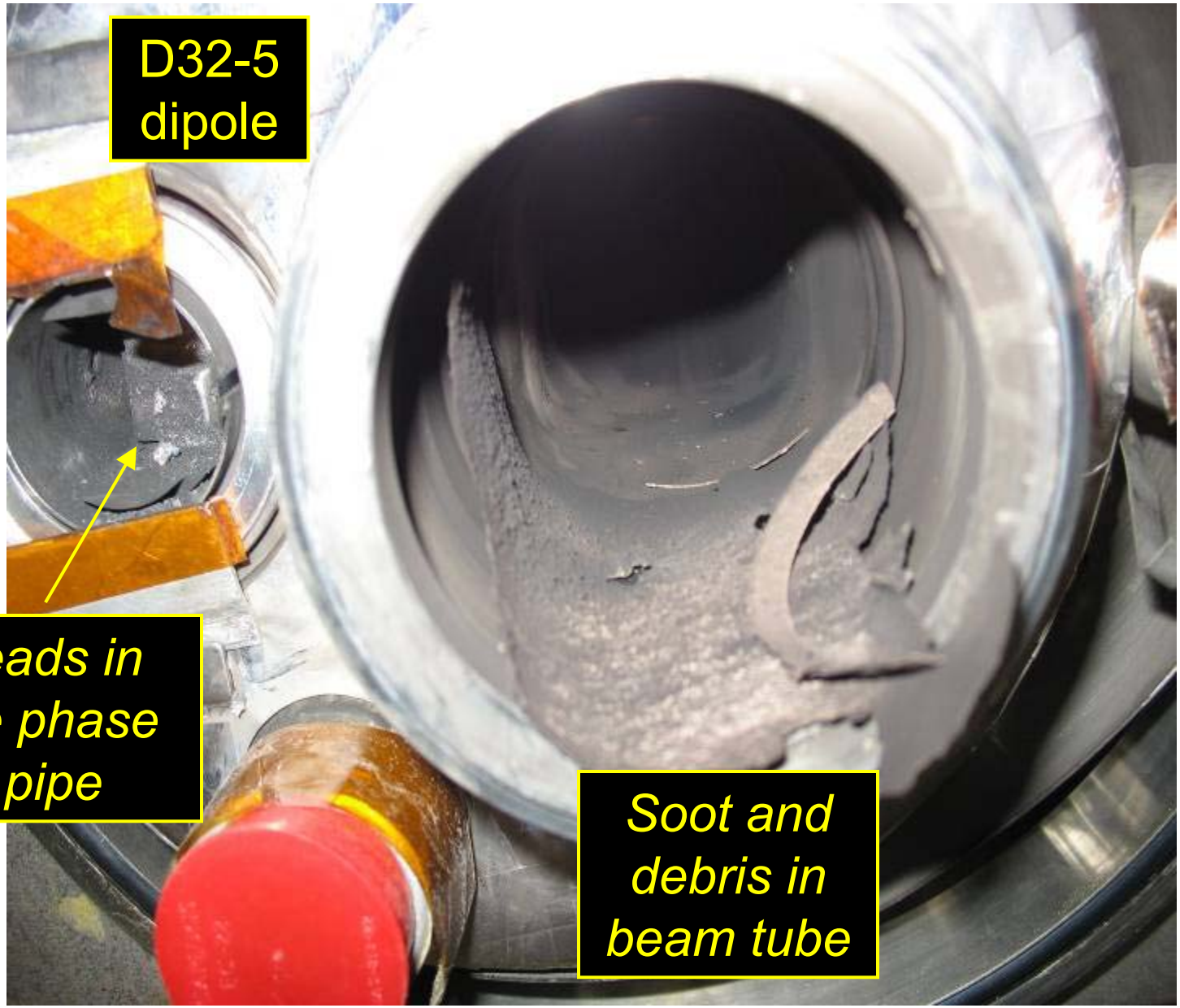
# Feeder 46B Cubicle near D0

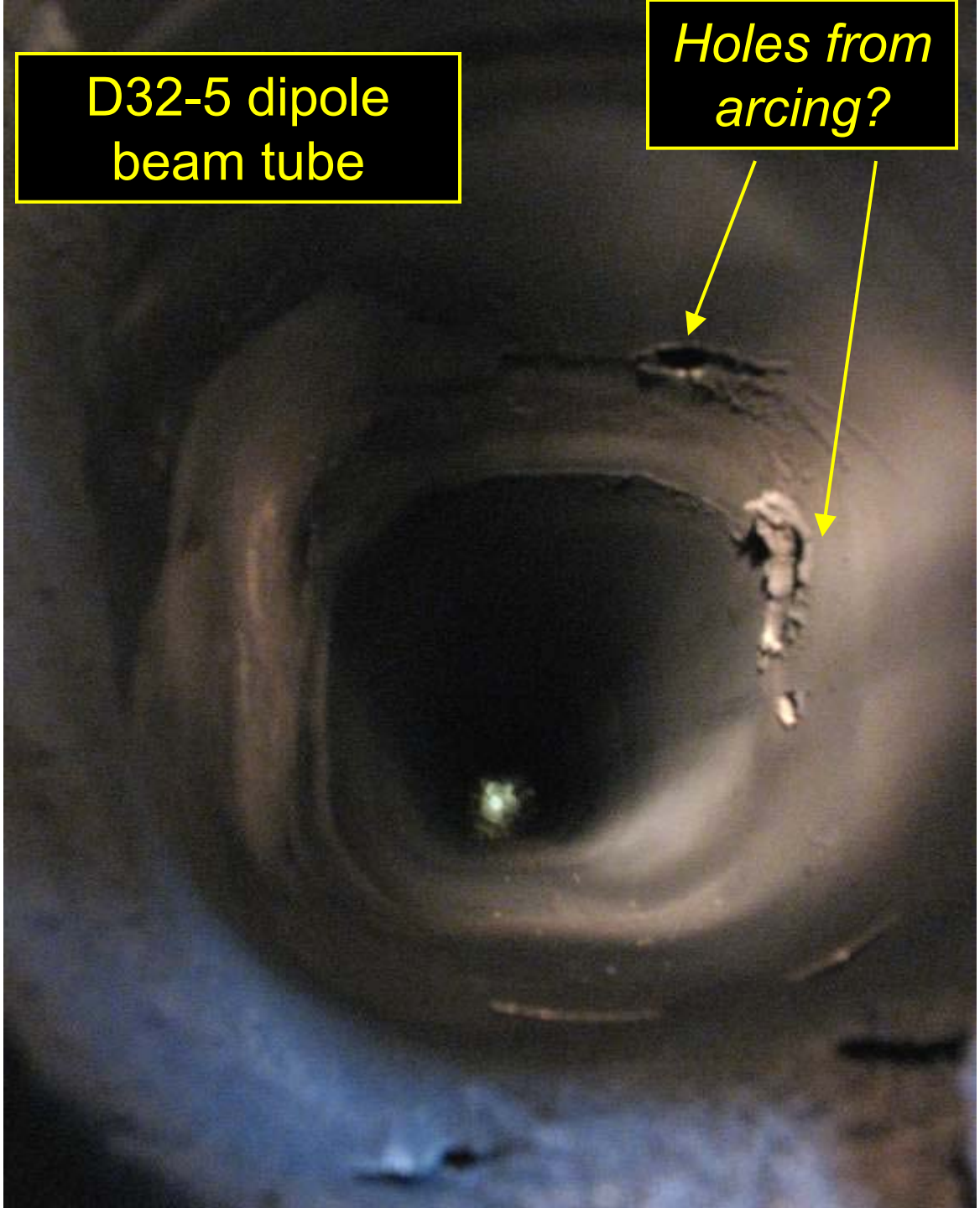
# The Culprit


D32-5
dipole
D33-1
quad
Soot and
pitting on
bellows
and
flanges
Superconductor
leads


D33-1
quad
Superconductor
leads

# D32-5 Dipole


D32-5 dipole
No leads in single phase He pipe
Soot and debris in beam tube


D32-5 dipole beam tube
Holes from arcing?

# The Aftermath

- Why that failure now?  Speculate that a problem was lurking there…
  - Mechanical stresses from this quench enough to cause failure
  - D3 quenches infrequent – last one was Sep 11, 2002
- What is being replaced?
  - D32-5 dipole and D33-1 quadrupole
  - D35 spool package (broken dipole corrector, unrelated to this failure)
- Helium and “soot” in beam tube
  - Sucked into beam pipe from single phase line after arc-through
  - Leaky isolation valves between adjacent sectors…D1-D2-D3-D4
    - Complicated vacuum recovery
  - Swabbed out ≥10(?) magnets – required moving into aisle
  - Concern about separators
    - RGA scans show plenty of helium, but little carbon or hydrocarbons
    - More optimistic now, still want to power them up soon to check
    - Will need time for conditioning, can be done during cool-down